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GCSE MATHS

Algebra

Edexcel 1MA1 | Subtopic collection Topic 30

Gradients and areas under graphs

Higher tier

Answers and examiner comments

7	2017-2024	Higher
question groups	available papers	tier

Using this booklet

1. Answer numbers match the companion question booklet.
2. Follow the original question number on marking tables.
3. Examiner comments are included where available.

Name _____ **Date** _____

Some entries use full source marking material in an appendix. Any unavailable mark schemes are identified beside the relevant answer.

Question	Working	Answer	Mark	Notes
18 (a)	values 0, 2, 5, 10,18	130	M1	for starting to find area under the curve, eg 0.5×5×2 (= 5)
			M1	for a complete method to find the area under the curve using 4 strips of equal width, eg "5" + 0.5×5×(2+5) (= 17.5) + 0.5×5×(5+10) (= 37.5) + 0.5×5×(10+18) (= 70)
			A1	for 130 or answer in range 130.1 to 132 supported by accurate working
(b)		overestimate with reason	C1	for "overestimate" and appropriate reason linked to method eg area between trapeziums and curve also included

Paper: 1MA1/2H

Question	Answer	Mark	Mark scheme	Additional guidance
21 (a)	52.5	P1	starts to find area under graph, eg $\frac{30\times12}{2}$ (=180) **or** 50 × 12 (=600) **or** $\frac{20\times12}{2}$ (=120)	
		P1	complete process to find area under graph, eg $\frac{30\times12}{2}+50\times12+\frac{20\times12}{2}$ (= 900)	
		P1	starts process to find half way time, eg (("900" ÷ 2) – 180) ÷ 12 (=22.5)	
		A1	52.5 oe	
(b)	Comparison	C1	acceptable comparison **Acceptable** (acceleration) during first part is positive but (acceleration) during last part is negative / deceleration (acceleration is) greater during the last part than during the first part gradient is steeper in the last part / longer to speed up than slow down speed / (acceleration) is increasing at start and decreasing at end (acceleration) is slower in the first part (acceleration) is ascending in the first part and descending in the last part 0.4 is the first part and –0.6 in the last part **Not acceptable** goes down in the last part speed is greater in last part than first part	

Paper: 1MA1/2H

Paper: 1MA1/3H

Question	Answer	Mark	Mark scheme	Additional guidance
16 (a)	129 to 160	M1	for a method to find an estimate for the area under the curve eg $0.5 \times 30 \times 9$	Do not accept 30×9
		A1	for value in the range 129 to 160 (If M0, SC B1for 126 or 127.5)	Award full marks for any correct method leading to a better estimate.
(b)	underestimate with reason	C1	(dep M1) for "underestimate" and appropriate reason linked to their method, eg area between triangle and curve not included	
(c)	Explanation	C1	for explanation, **Acceptable examples** method gives average acceleration (in first 60 seconds) he has not used/drawn a tangent (at time 60 seconds) he has not worked out the gradient (at time 60 seconds) **Not acceptable examples** he has not used strips he has calculated it accurately rather than using an estimate the estimate of 13 should be about 4.4 the answer should be approximately 0.073	

21	(a)	19.1	M1	for a method to find an estimate for the area of at least 1 trapezium under the curve eg $0.5 \times 1 \times (4 + 6)$ or $0.5 \times 1 \times (6 + 7.2)$ or $0.5 \times 1 \times (7.2 + 7.8)$	
			M1	for a complete method eg $0.5 \times 1 \times (4 + 6) + 0.5 \times 1 \times (6 + 7.2) + 0.5 \times 1 \times (7.2 + 7.8)$ or $0.5\{(4 + 7.8) + 2(6 + 7.2)\}$	Allow a maximum of 2 errors in y values used
			A1	cao	Ignore any reference to units
	(b)	Statement	C1	eg distance (travelled)	If units are given they must be correct

14	(a)	0.9	M1 for drawing a tangent at $t = 2$	
			M1 for a complete method to find the gradient eg tangent at $t = 2$ and "2.7" ÷ "3"	Use of change in y over change in x Working may be seen on the diagram
			A1 for answer in the range 0.7 to 1.1	Accept answers in the form $\frac{a}{b}$ where a and b are integers
	(b)	Statement	C1 eg distance (travelled)	If units are given they must be correct

Paper: 1MA1/1H

Question	Answer	Mark	Mark scheme	Additional guidance
14 (a)	–2.5	M1	for drawing a tangent at $t = 5$	No tangent drawn score 0 marks
		M1	(dep on M1) for a complete method to find the gradient eg tangent at $t = 5$ and "10" ÷ "4" **or** an answer in the range 2.0 to 2.8	Working may be seen on the diagram
		A1	for answer in the range –2.0 to –2.8 dependent on tangent drawn	Accept answers in the form $\frac{a}{b}$ where a and b are integers
(b)	79	M1	for a method to find an estimate for the area of at least 1 trapezium under the curve, eg $\frac{1}{2}\times 2\times(25+16)$ $(=41)$ oe or $\frac{1}{2}\times 2\times(16+9)$ $(=25)$ oe or $\frac{1}{2}\times 2\times(9+4)$ $(=13)$ oe **or** for a method to find an estimate for the area of at least 1 rectangle with heights at intersection of midpoint and curve, eg 2×20.5 $(=41)$ oe or 2×12.5 $(=25)$ oe or 2×6 $(=12)$ oe	May be seen as a rectangle added to a triangle Allow consistent use of incorrect width for both M marks
		M1	for a complete method, eg $\frac{1}{2}\times 2\times(25+16)+\frac{1}{2}\times 2\times(16+9)+\frac{1}{2}\times 2\times(9+4)$ oe or $\frac{1}{2}\times 2\times(25+4+2(16+9))$ **or** $(2\times 20.5)+(2\times 12.5)+(2\times 6)$	Allow 1 error in y values used
		A1	For 79 or 78	Allow 78 only if it comes from rectangle/midpoint method

Paper: 1MA1/2H

22	1760	M1	for starting to find the area under the curve, eg 0.5 × 10 × **54** (= 270) oe or 0.5 × 10 × (**54** + **76**) (= 650) oe or 0.5 × 10 × (**76** + **92**) (= 840) **or** for a method to find an estimate for the area of at least 1 strip with heights at intersection of midpoint and curve eg 10 × [**39**] oe or 10 × [**67**] oe or 10 × [**86**] oe	Must have one correct expression for the award of this mark May be seen as a rectangle added to a triangle Where 38 ≤ [39] ≤ 40 Where 66 ≤ [67] ≤ 68 Where 85 ≤ [86] ≤ 87
		M1	for a complete method to find the area under the curve, eg 0.5 × 10 × 54 + 0.5 × 10 × (54 + 76) + 0.5 × 10 × (76 + 92) oe eg 0.5 × 10 (92 + 2(54 + 76) **or** 10 × [39] + 10 × [67] + 10 × [86] oe	Allow 1 error in *y* values used
		A1	for 1760 or 1890 to 1950 SCB2 for an answer in the range 1815 – 1855	Allow 1890 to 1950 only if it comes from midpoint method

Paper: 1MA1/3H

Question 21

There was a lot of misunderstanding of what was being asked for in this question, particularly confusion between speed and acceleration.

In part (a) some found the half way mark on the time axis and gave the answer as 50 or used distance/speed/time. Of those that realised they needed to work with the area under the graph a large number made an error with the vertical scale using 12.5 or 14 for the speed. Some made errors using the formula for the area of a triangle. However, many still gained the first make for starting to find an area.

In part (b) few students realised the first part was acceleration and the last part deceleration, though they did notice that the last part was greater than the first part because the gradient was steeper. Some responses gave no comparison.

Question 16

Many students worked out an estimate for the distance the car travelled by drawing a triangle under the curve, perhaps the expected approach. Working written by these students was generally accurate and the answers 132 and 135 within the given range and scoring two marks in part (a) were common. Unfortunately, as many if not more students merely multiplied either 8.8 or 9 by 30. This estimate was viewed as being too far from the actual distance travelled and did not convince examiners that students realized that the area under the curve gives the distance travelled. Some students used more than 1 triangle, for example using 2 strips and requiring the student to find the total area of a triangle and a trapezium. This method, an example of one providing a better estimate than when using a single triangle, was, of course, awarded full marks provided it was accurately carried out.

Answers to part (b) were often well expressed. The mark was awarded for a clear answer linked to an acceptable method for estimating the area in part (a). Vague answers such as “an underestimate because of the curve” could not be given the mark. Some students based their answers on the effects of rounding values of the speed rather than comparing the estimate calculated for the area under the curve with the exact area.

Part (c) was answered correctly only by better students who focused on the need to draw the tangent to the curve at time 60 seconds or on calculating the gradient of the curve at this point (or both). Many students attempting to answer this part of the question restricted their answers to a discussion of rounding. This was not accepted as an explanation worth crediting.

Question 21

A good number of students demonstrated how to estimate the area under the curve by using 3 trapeziums though some students used only one or two trapeziums.

Unfortunately, a large number of students were unable to access full marks for their answers because they used incorrect y values for $t = 3$ and/or for $t = 4$. Most students did gain some credit for a correct expression for at least one of the areas, usually for the trapezium between $t = 1$ and $t = 2$. It was encouraging to see students using the formula for the area of a trapezium rather than splitting the trapezium into a rectangle and triangle. These students were usually more successful in terms of the number of marks they got for their answers.

Answers to part (b) were often correct though there were a significant number of answers stating that the area represented either acceleration or speed. Units of measurement for the distance were not required but where these were given they were invariably correct.

Question 14

Where tangents were drawn they were generally accurate and students often went on to gain all three marks for working out an estimate of the gradient that was within the acceptable range. Some answers were given in the form a/b and the final mark was lost when a and b were not integers. Errors were often the result of reading the scales incorrectly although some students divided the change in x by the change in y. A significant number of students drew a tangent, thus gaining the first method mark, but could not then complete the method to find the gradient. Many students used the coordinates of the point on the curve at $t = 2$ and simply divided 2.8 by 2. Some of these students had already drawn a tangent to the curve at $t = 2$.

In part (b) many students knew that the area under the graph represents the distance travelled. Incorrect answers often referred to acceleration or to time. Some students gave the answer as velocity or speed.

Question 14

This question tested two topics that were new to 1MA1 and students are now scoring some good marks. In part (a) a tangent needed to be drawn and the gradient calculated. Many gained the first mark for drawing the tangent, and of those a significant number gained the second mark for a correct method to find the gradient. Unfortunately, many who did this, lost the third mark due to a missing negative sign in their answer. Weaker students read off at $x = 5$ and either multiplied or divided these two values, and thus scored zero. In this question, if no tangent was drawn, no marks could be scored.
In part (b) a method to find the area under the curve was required and a pleasing number attempted this with trapezia. This was also seen in terms of triangle and rectangles, which was perfectly acceptable. To gain the first mark, a single correct area of a trapezium (or rectangle and triangle) was required, with a complete method needed for the second M mark. Those who used rectangles whose height was the point where the middle of the bar crossed the graph could also gain full credit here, and normally did. This method led to an answer of 78 compared to the 79 got from the other.
Quite a few found the area under the tangent or had problems reading from the scale, but method marks could still be gained if this was limited to just one error.

Question 22

Various responses were seen to this question with common incorrect answers being from 30×92 or $54 \times 10 + 76 \times 10 + 92 \times 10$. Of those who gained just one mark it was usually for correctly finding the area of the triangle in the first section. Of those that had an appreciation of what they needed to do, many limited their marks by incorrectly reading values from the graph or not doing as instructed and using 3 strips of equal width.